RECYCLING TECHNOLOGY

Starlinger

RECYCLING TECHNOLOGY FOR FILM

for single- and multi-layer film, all conventional polymers, **in-house and post-consumer scrap,** in- and off-line, **state-of-the-art technology,** high automation and energy saving, **pellets for up to 100 % reuse**

Increasing competitiveness & value *through recycling*

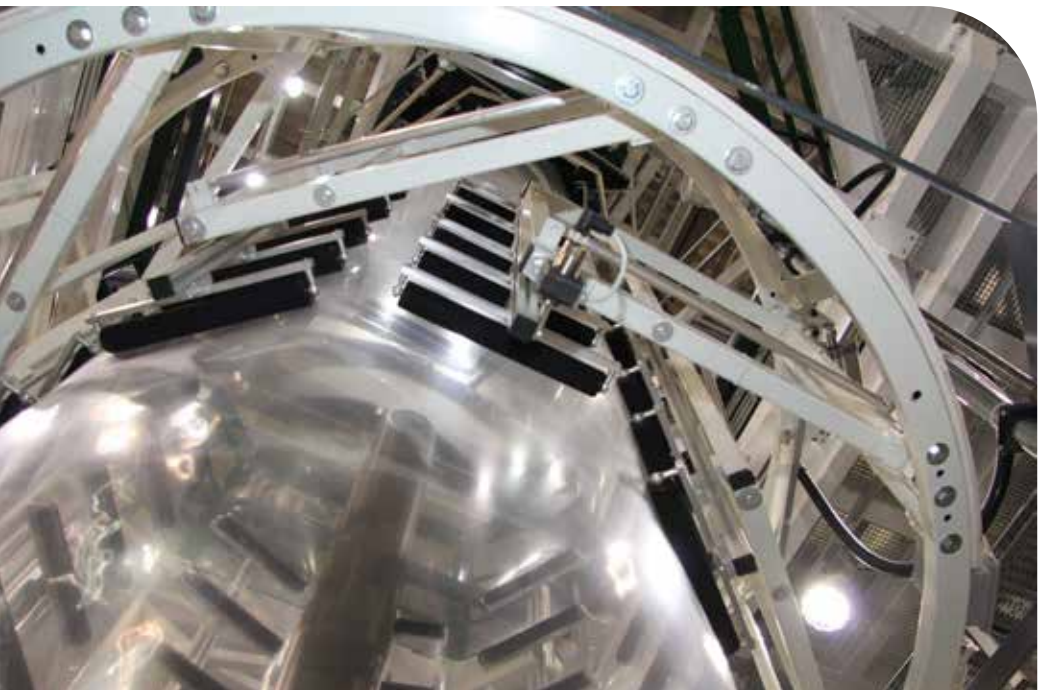
Recycling is the first step in a second life cycle by treating post-consumer and production scrap as a valuable secondary resource.

Characteristics like flexibility, low weight, barrier properties, and heat resistance have made plastic the material of choice for packaging. In many cases plastic has replaced other packaging materials. For some polymers – polyethylene, for example – film makes up more than 50 % of the usage.

Know-how is required to utilise new resins and/or processes (e.g. multi-layer) that help converters to increase the value of the produced film and stay competitive. Having said that, film in general is a commodity, and cost reduction essential to survive.

Starlinger recycling technology – solutions first

For the film recycling industry, Starlinger recycling technology offers a spectrum of innovative machinery solutions for the efficient recycling of all kinds of film materials. A variety of film types such as mono-layer and multi-layer films, biaxially oriented films, same polymer or blend, varying MFI, heavily printed and perhaps even metallized, among others, are produced. The sources of the waste are in-house production scrap, post-industrial waste (e.g. from film conversion), as well as post-consumer waste, which also includes agricultural film. Polymers (or their blends) such as PE (LDPE, HDPE, LLDPE, mLLDPE), PP (BOPP), PA (BOPA), PET (BOPET), PS, PLA, etc. can be processed with a choice of pre-treatment, extrusion, filtration and pelletising modules.
The technology has to be flexible to be able to process different and varying input streams, but also because of the non-predictable future. High automation and optimised maintenance procedures are needed to fulfil the high uptime rates.
An increasingly important role plays upcycling through using additives.



The expectations in packaging are increasing constantly; hence the complex structures of different polymers in a multi-layer film that challenge the production technologies. At the same time, the use of regranulate is a factor that contributes to competitive film production.

RECYCLING
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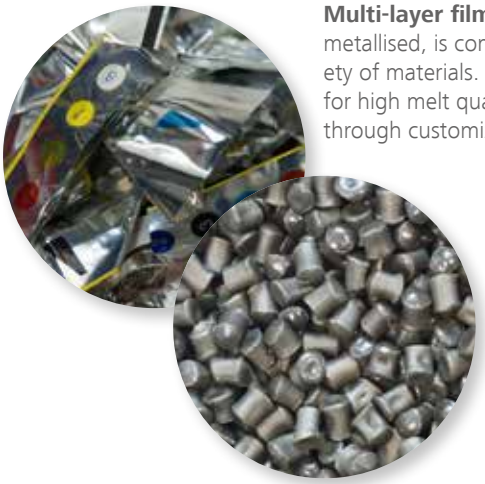
Recycling production scrap: *maximising profit in-house*

Recycling and/or using regranulate is a major factor to reduce film production costs and, at the same time, contributes to resource conservation.

Dealing with production scrap is necessary throughout the film production chain, no matter if the production process is for blown film or cast film. The film structure is either mono-polymer or a mixture of polymers. The scrap occurs continuously as edge trim, and discontinuously as solid start-up lumps, loose film, off-spec reels and cut outs. Sometimes the waste film is already printed, laminated or metallized when collected. In the best case, the scrap is clean and dry; in reality it might have become humid through outside storage, or be contaminated with paper labels or metals. At the same time, a variety of economic factors like rising resin prices, pressure to reduce costs, and stronger competition have led to higher awareness concerning the costs of production scrap. Inhouse film waste requires simple and cost-effective set-up of the recycling equipment for fast ROI.
We at Starlinger recycling technology consider production scrap a valuable secondary resource for producing first-class products. Recycling of production scrap contributes considerably to cost savings by avoiding waste disposal costs and replacing virgin resin. The choice of the right equipment is fundamental in order to increase the regranulate content in the primary product up to 100 %.
The result: higher competitiveness, resource conservation and a high-quality end product.

Film recycling – a wide range from commodity to speciality

Heavily printed film requires efficient degassing solutions: Highest efficiency is achieved with the Starlinger C-VAC module. Optionally, the line can be equipped with $CaCO_3$ flushing for increased machine uptime.



Multi-layer film, sometimes metallised, is composed of a variety of materials. Homogenisation for high melt quality is achieved through customized screw design.

Lamination structures are made of different polymers, e.g. PET/PE, or different materials, e.g. polymer/aluminium. Reuse of the material is possible to a certain extent by separation; the tool of choice is a speciality filter.

BOPP, BOPET and BOPA production scrap requires sophisticated material logistics as it occures discontinuosly and has low bulk density. Starlinger offers turn-key projects from edge trim cutting to final pellets storage.

In-line recycling of various trims from stretch film production is recommended. Full attention of the operator on the main process is ensured through high automation of the recycling line, e.g. automatic stand-by/restart mode.

Bioplastics, e.g. corn starch based film, are often highly hygroscopic and temperature sensitive. The recycling line has to be prepared accordingly, e.g. pre-drying in the SMART feeder and excellent degassing.

Post-consumer & industrial recycling: *Trackling the task*

The input material can be in different conditions. Important is to choose a recycling system which can be adapted to future challenges not yet known.

A variety of disturbing factors can pose a challenge to the recycling process and consequently influence the quality of the regranulate. In case of post-industrial waste (production scrap not processed inhouse, conversion scrap from slitting, etc.), the material might be wet from outside storage, printed, or dirty from inappropriate materials handling. Additionally, the film scrap might be a mixture of unidentifiable polymers, or laminated with other materials such as paper or aluminium.

Post-consumer film waste can come from households or agricultural use. In both cases, the film has to go through a sorting and washing process before extrusion. The input material in the form of shredded flakes usually holds a high amount of humidity and foreign particles. Humidity and contamination are two main challenges in post-consumer recycling. Therefore the choice of equipment is crucial; the focus is on good drying, degassing and filtration. Depending on machine design, e.g. air-flushing of the SMART feeder or extruder degassing, humidity levels of up to 4% are possible. With optional equipment, materials with a peak humidity of up to 20% can be processed. Special solutions such as the C-VAC module and special melt filters are available in case of organic contamination such as paper or wood. Quality upgrades can be achieved with additives.

A huge range of materials – answers to real challenges

Agricultural film may show high levels of possibly abrasive foreign particles and humidity even after the washing process. Selecting wear-resistant materials for the parts in contact with the polymer increases life time and reduces operating costs.

Industrial packaging film often contains high paper content from labelling. The C-VAC module removes this kind of contamination before degassing and ensures the most efficient extraction of volatiles.

Sheet with aluminium film is available as skeleton waste from production of e.g. coffee cream containers or yoghurt cups; it may contain paper contamination. The special melt filtration system can handle up to 10 % non-polymer content.

Post-consumer packaging from households requires proper washing; the composition of the waste is often unknown to the recycler. SMART feeder and correct screw design ensure best homogenisation.

Polymer content of paper-based beverage containers shows high contamination of aluminium and paper, as well as high moisture levels. A combination of optimum drying in the SMART feeder and continuous filtration allows to produce reusable pellets.

PO labels, a side product of PET bottle washing, are highly printed and often contaminated with PET flakes. With the C-VAC module, PET contaminants are removed before entering the highly efficient degassing module.

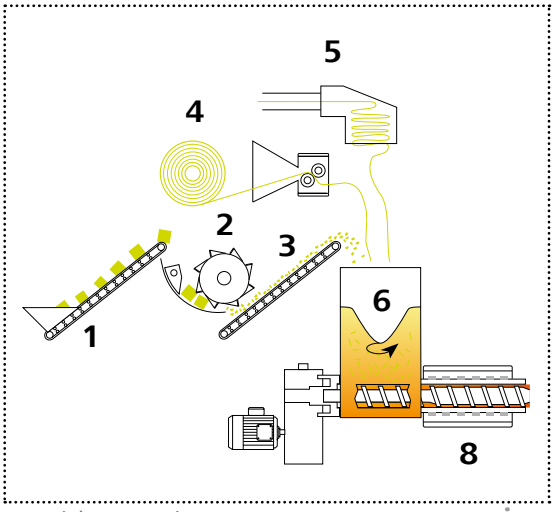
Production scrap as well as post-consumer waste comes in different conditions. The filtration system is selected according to contamination, the pelletising equipment according to type of polymer.

recoSTAR dynamic

Material	Humidity	Shape: Film	Lumps	Flakes
PE (LDPE, HDPE, LLDPE), PP (BOPP), PA (BOPA), PET (BOPET), PS, PLA	≤ 4 % standard ≤ 10 %* ≤ 20 % **	loose, preground, from reel	preground	yes

* Depending on inclusion of optional equipment
** With additional equipment

The recoSTAR dynamic recycling line features extended functonalities for processing in-house film production scrap and washed post-consumer waste. State-of-the-art technology guarantees higher automation and output, increased energy efficiency and a wider range of applications.
The SMART feeder ensures ideal material preparation prior to extrusion by simultaneously performing the following functions: **S**hrink & cut, **M**ix & homogenize, **A**ctive feed & control, **R**otate & friction, **T**emperature & dry. The dynamic automation package regulates the ideal operation point. The automatic speed adjustment of the rotating disc and positioning of the load-controlled intake slider increase the output. Fluctuating levels of humidity can be processed more easily.



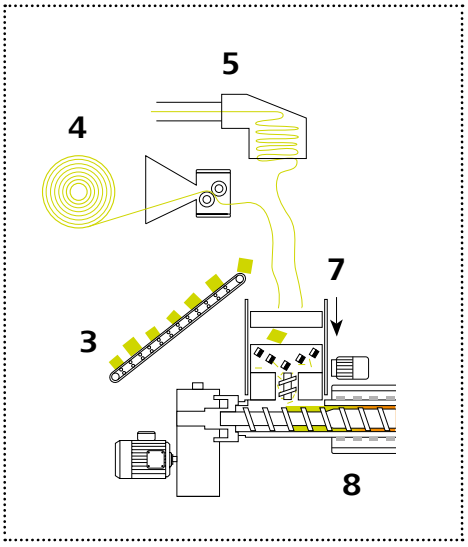
material preparation

recoSTAR universal

Material	Humidity	Shape: Film	Lumps	Flakes
PE (LDPE, HDPE, LLDPE), PP (BOPP), PA (BOPA), PET (BOPET), PS, PLA	≤ 2 % standard ≤ 4 % *	loose, from reel	yes	yes

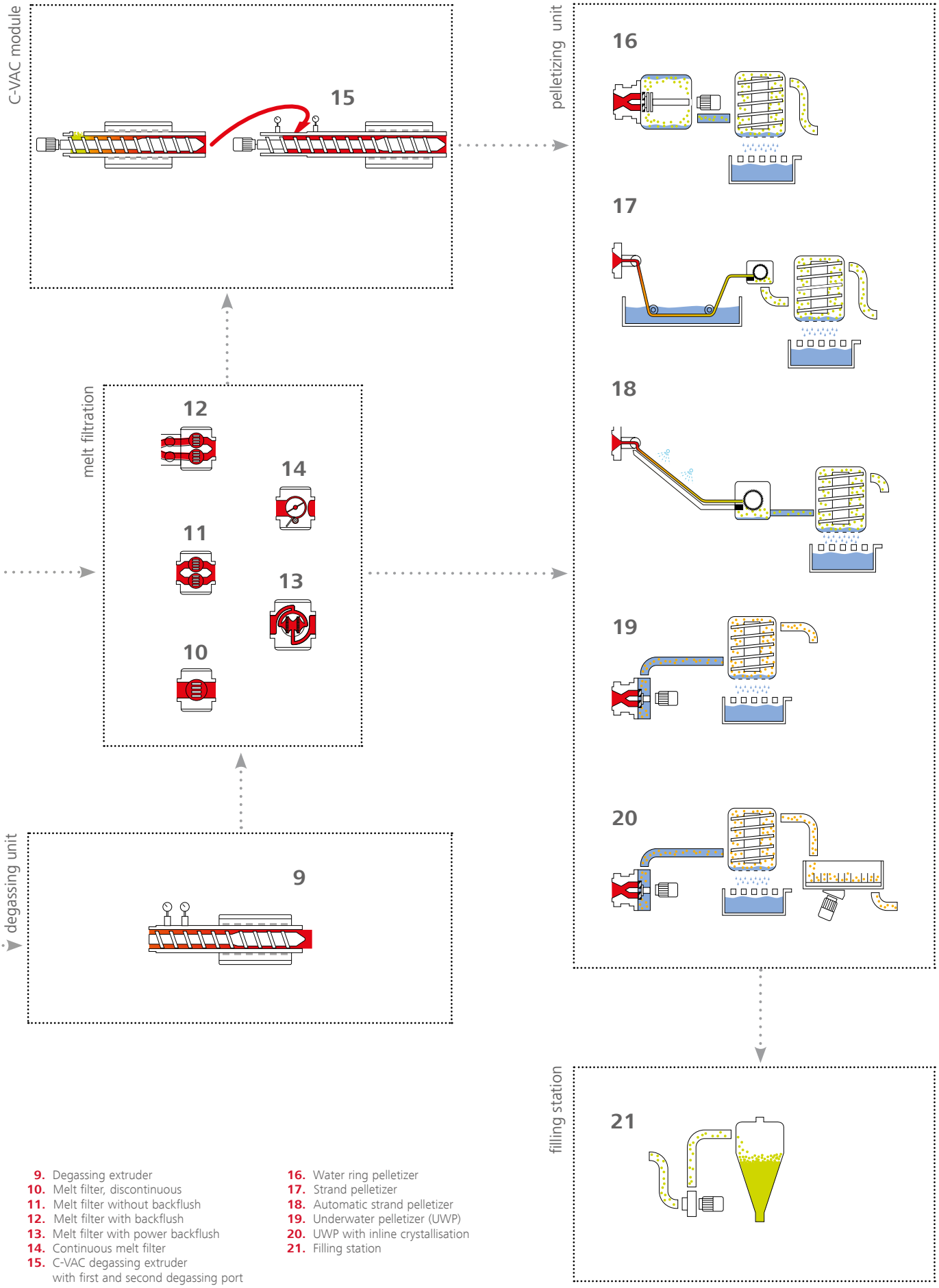
* Depending on inclusion of optional equipment

The recoSTAR universal recycling line is the most efficient solution for rigid, flexible (also in bales) and hard-to-grind production scrap, and features three-drive design. The integrated ACTIVE shredder ensures versatility, easy accessibility for high up-time, and intelligent operation through innovative process adaptions.
The ACTIVE shredder ensures perfect material preparation for high output through exact cutting geometry and rotor design. ACTIVE stands for **A**ccessibility & quick colour change, **C**ontrolled cutting & dosing, **T**ight knife clearance & high performance, **I**ntelligent & innovative, **V**ersatile & wide material range, **E**asy start & stop operation. The curved hydraulic pusher and load-controlled dosing screw allow stable extruder feeding. Easy access and maintenance grant high uptime.



material preparation

1. Conveyor belt/screw
2. ACTIVE shredder, stand alone
3. Conveyor belt with metal detector
4. Nip roll feeder
5. Edge trim cyclone
6. SMART feeder
7. ACTIVE shredder with dosing screw
8. Extruder



9. Degassing extruder
10. Melt filter, discontinuous
11. Melt filter without backflush
12. Melt filter with backflush
13. Melt filter with power backflush
14. Continuous melt filter
15. C-VAC degassing extruder with first and second degassing port
16. Water ring pelletizer
17. Strand pelletizer
18. Automatic strand pelletizer
19. Underwater pelletizer (UWP)
20. UWP with inline crystallisation
21. Filling station

European competence – solution oriented

Recycling of production scrap and post-consumer waste means adapting to changes of input materials. Starlinger recycling technology sets the focus in machine construction on modularity, increased automation, user-friendliness in operation and maintenance, improved production efficiency and high ROI.

rECO and other features:

- With **rECO** design, the overall energy consumption kW/kg is reduced by approx. 10 %. The benefit is reduced costs and carbon footprint.
- User-friendly control panel design, RFID-chip operator identification, LED user elements, automatic start-up and stand-by, one-button start/stop, etc.
- Each visualisation page can be stored as a screen shot. Recipes can be transferred from one line to another by simply pressing a button.
- The integrated maintenance list indicates preventive maintenance works, thus keeping up-time high.
- Integrated storage of the main production parameters (extruder load, melt pressure, etc.) which can be displayed as trends on the colour touch panel.
- Up-cycling: recoBATCH combines the traditional recycling process with the compounding of additives. The quality of the regranulate during extrusion is improved.

rECO is an innovative approach that improves the energy efficiency of the recycling line.

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