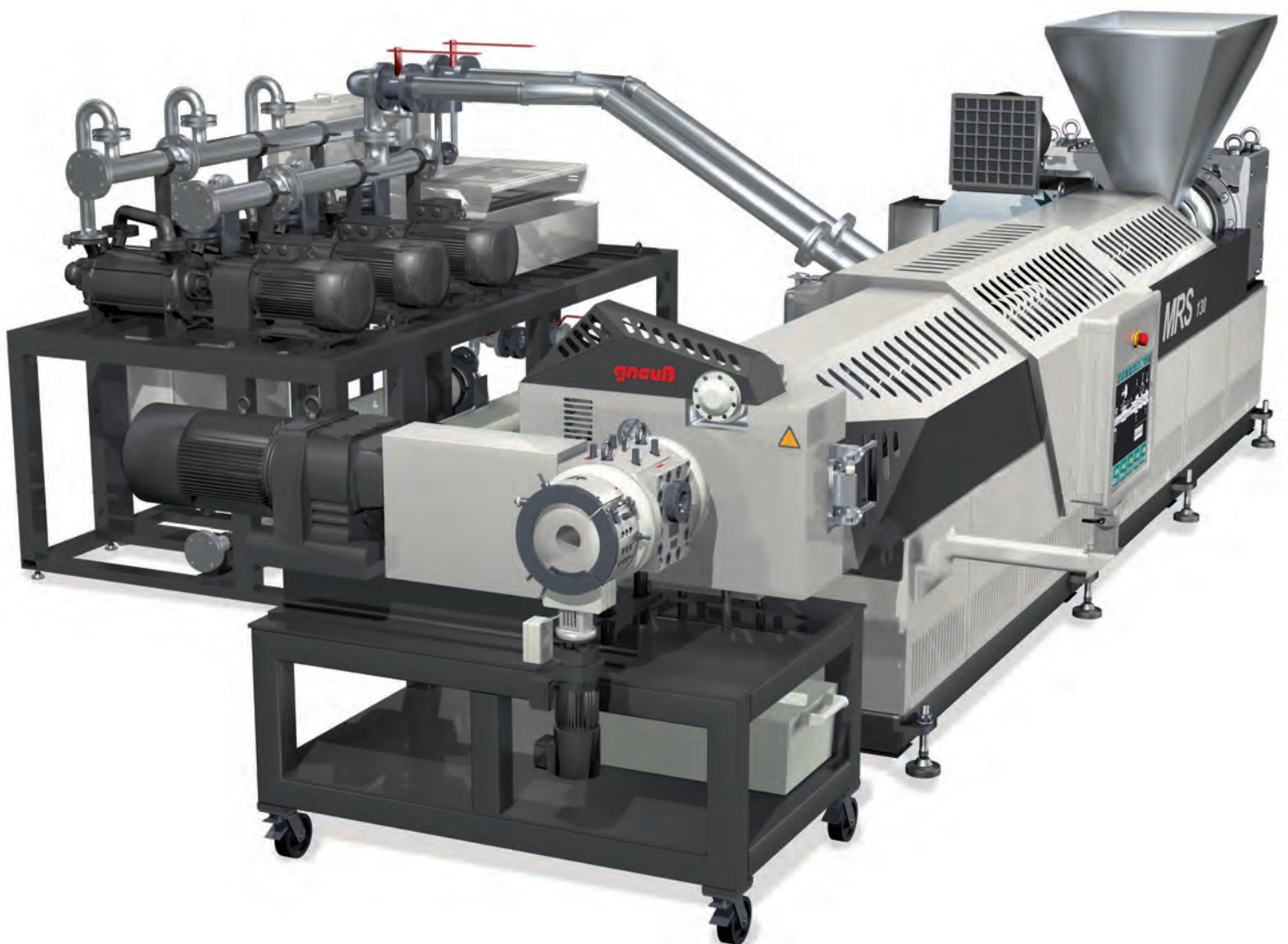


**POLYESTER**

**TECHNOLOGY**



Gneuss Technologies for Polyester Recycling  
Made in Germany

**gneuß**

# WELCOME TO GNEUSS

It's good that you're here

This family owned company owns more than 60 international patents and can look back on 30 years of experience. Gneuss has made a name for itself as a supplier of innovative solutions for the plastics processing industries. In the field of Polyester Technology, Gneuss focuses on the optimization of PET extrusion processes where up to 100 % recycled material is used.



Based in Bad Oeynhausen, Germany, Gneuss is committed to the expectations of products "made in Germany" while serving customers worldwide. With its subsidiary in the USA, offices in Brazil and China, a cooperation partner in Japan and together with representatives worldwide, Gneuss is present throughout the world.

The best possible technical support, excellent field service and spare parts availability is provided on all five continents. Support is available around the clock via a telephone service hotline. Pilot lines for trials, development, and prompt product shipment are available at several locations.

## BUSINESS AREAS



Processing Technology



Filtration Technology



Measurement Technology

# CONTENT



## Gneuss Technologies

Gneuss' unique technologies are being used worldwide for many years now and they are particularly well established in polyester processing applications.

Page 4



## Sheet Manufacture

The innovative MRS Technology allows the manufacture of high quality, food contact approved packaging sheet from heavily contaminated post consumer PET bottle flakes without the need for crystallization or pre-drying – without any pre-treatment of the flakes and with a single filtration step.

Page 6



## Repelletizing

The outstanding performance characteristics of the MRS extruder are also of major advantage in the processing of PET bottle flakes to pellets (chip). The result is a material which is suitable for food contact applications – with high quality and clarity.

Page 8



## Fiber Manufacture

The demand for environment-friendly and economically sound production lines for synthetic fibers is increasing worldwide. The Multi Rotation Extrusion System MRS fulfils both demands equally.

Page 10



## Recycling of Industrial Waste

In cooperation with worldwide specialists, Gneuss offers complete system solutions including size reduction, feeding and direct processing of in-house waste, skeletal waste and edge trim.

Page 12



## Gneuss Modules

**Extruder MRS**

**Rotary Filtration System**

**Vacuum Technology**

**Online Viscometer**

**Control Technology**

**Pressure and Temperature Measurement**



Page 14

# GNEUSS TECHNOLOGIES

## Multifaceted Applications in Polyester Processing

Since the company was founded in 1983, Gneuss has positioned itself as the technology leader for machines and systems for the reprocessing of all kinds of polymer waste. The unique Rotary Filtration Systems enable constant production without quality variations or process disturbances even during screen changes. The MRS extruder is the only extruder developed explicitly for the direct processing of PET flakes without pre-drying. All processing conditions are monitored precisely with sensors from the Gneuss Measurement Technology range. Gneuss has been applying these key technologies worldwide for many years now and they are particularly well established in PET processing applications.

Wide range of different applications with reclaim material e.g. PET bottle flakes, skeletal waste and edge trim from sheet and film, fiber waste, agglomerates, reground start up lumps, pellets / chips etc.



Production of packaging, film, fiber and pellets/ chips for food contact



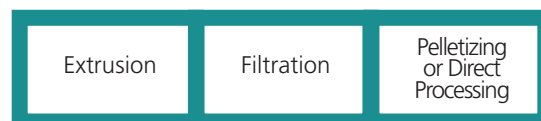
## Major Savings Potential

One of the most significant advantages offered by Gneuss' MRS Extrusion Technology compared to conventional extrusion technologies is that the costly and time-consuming steps of pre-drying and crystallizing of the material are eliminated.

### — Conventional PET Processing Steps during Recycling —>



### — The Gneuss way: MRS Technology Steps —>



Gneuss' MRS Extrusion Technology ensures a polymer melt with maximum purity – permanently. Solid contaminants are removed by highly efficient Melt Filtration Systems and soluble contaminants such as oils, oligomers, pigments and solvents are efficiently removed from the polymer in the melt phase under vacuum in the MRS extruder.

#### Economic Advantages

- Reduced space requirements
- Major energy savings
- Reduced maintenance and personnel costs
- Simple, robust and economic vacuum technology
- Simple operation thanks to fully automatic control system
- High flexibility – for example with regard to material changes
- 100 % recycling of post consumer and/ or industrial waste
- Direct processing to food contact products (FDA LNO)
- High quality final products

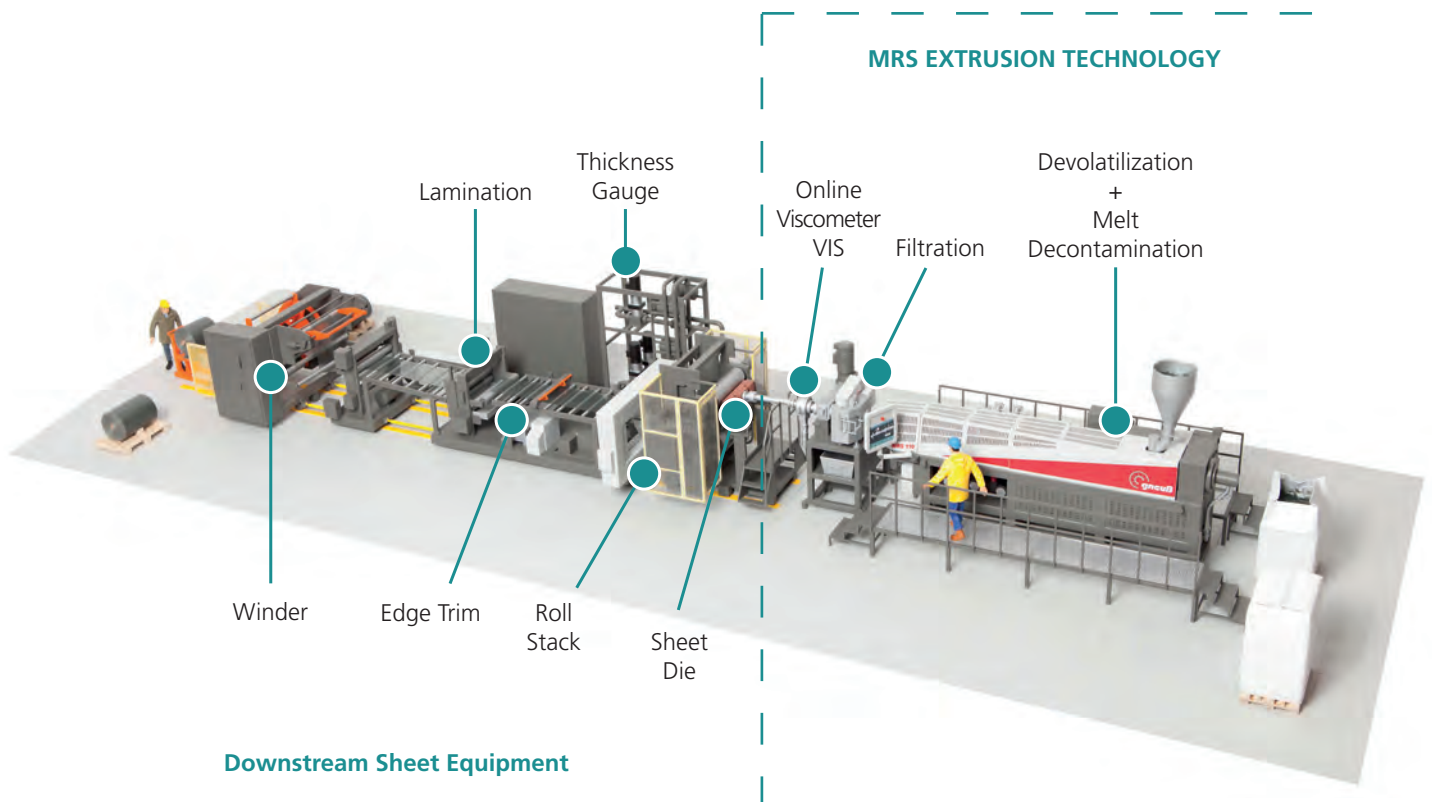
# SHEET MANUFACTURE

Well Packaged: clear and shiny

**In comparison to conventional systems, Gneuss' PET Processing Technology allows even heavily contaminated post-consumer PET bottle flakes to be processed into high quality, food contact approved sheet without the need for crystallizing or drying – and without any pre-treatment of the flakes and with a single filtration step.**

The MRS extruder's devolatilization step not only removes water in the melt phase, it also ensures efficient decontamination – for example successfully tested for food contact according to the FDA challenge test. The rugged and compact design reduces the complexity of the line. Maximum line availability and minimum maintenance requirements are ensured.

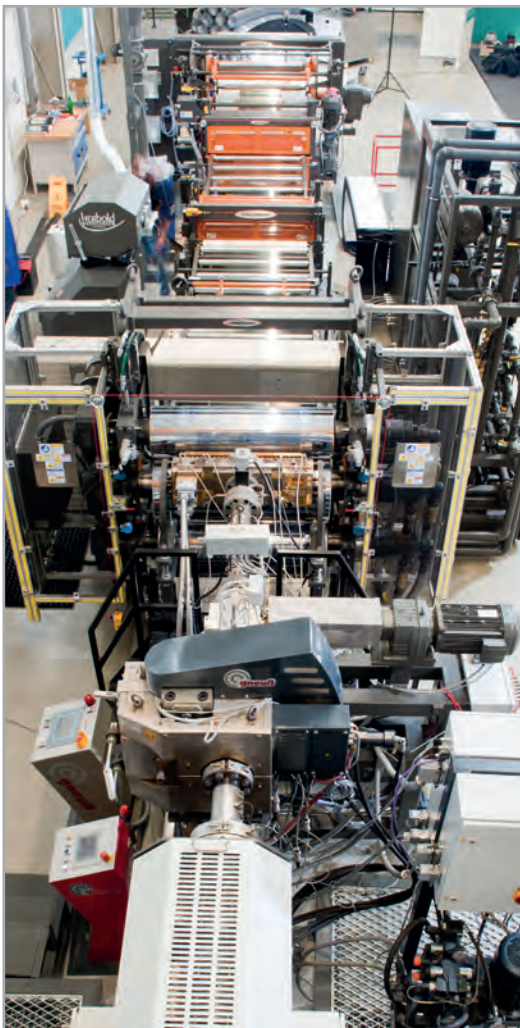
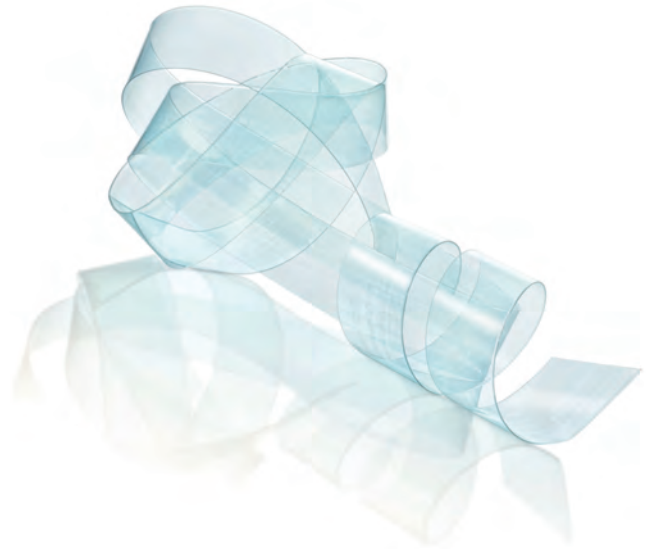
Regrind from edge trim and skeletal waste, bottle flakes, virgin material and masterbatch are processed without pre-drying. The extruder vacuum system utilizes a simple, rugged and low maintenance water ring vacuum pump. For PET thermoforming sheet, Gneuss offers turnkey concepts from A to Z, but the MRS can also be combined with existing downstream equipment.



**Example of a PET Thermoforming Sheet Line:**  
Multi Rotation Extruder MRS  
Rotary Filtration System RSF*genius*  
Online Viscometer VIS,  
Downstream Sheet Equipment

### Advantages of Gneuss Technologies for Thermoforming Sheet Manufacture:

- High gloss and transparency
- Low yellowness
- FDA LNO for food contact for up to 100 % post-consumer reclaim content
- Direct food contact for both monolayer and co extruded sheet
- Sheet thickness from 150 - 1000 µm
- High IV stability
- Major energy savings



## LNO of FDA

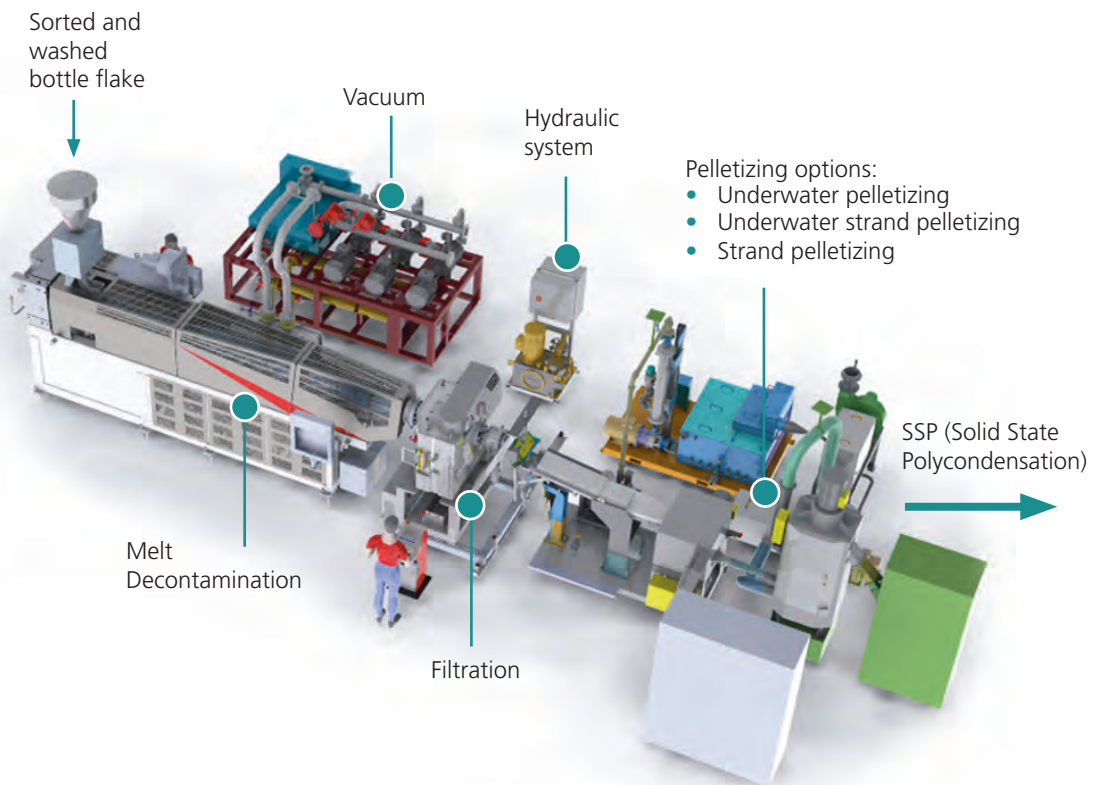
### Options:

- Gravimetric dosing of multiple components
- Co-extrusion
- Lamination
- Antiblock / Antistatic coating
- Thickness scanning with optional control loop to automatic die
- Sheet inspection system
- Stress analyzer

# REPELLETIZING

PET pellets reprocessed to the highest quality

The exceptional performance characteristics of the MRS extruder and the Rotary Melt Filtration Systems also offer major advantages for repelletizing processes.



## Example of a Bottle to Bottle Line

Multi Rotation Extruder MRS, Rotary Filtration System RSF*genius*, Online Viscometer VIS, underwater pelletizer and residual heat crystallization. Downstream (optional): SSP with short residence time for solid state polycondensation up to the required IV of 0,8.

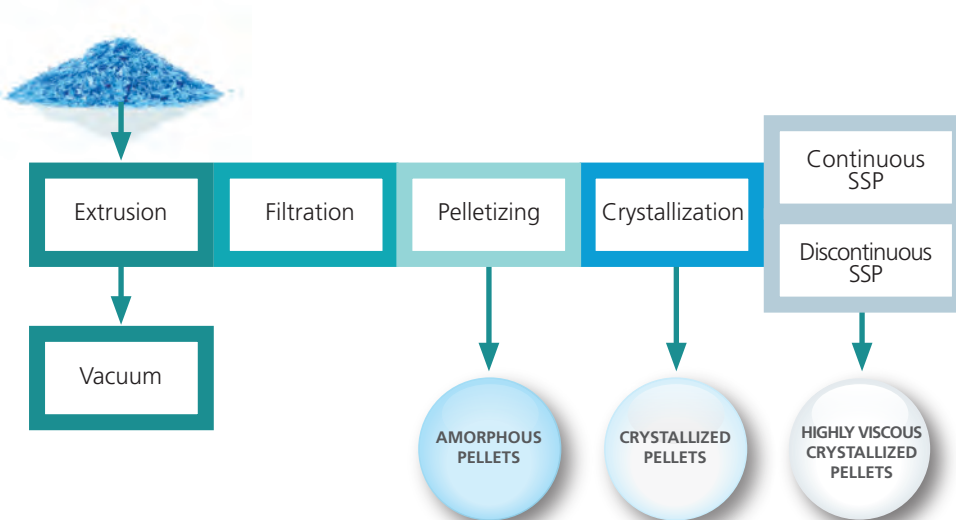
The MRS extruder processes undried PET bottle flake without any pre-treatment directly into pellets. The polymer melt is intensively and rapidly exchanged in the multiple screw section of the extruder. The huge surface area is exchanged at an unparalleled rate so that even with a moderate vacuum level of 25 to 40 mbar in the degassing

section, contaminants are efficiently evaporated out of the melt. The decontamination efficiency has been confirmed by an FDA LNO. Viscosity loss is controlled and minimal. With regard to transparency and yellowness, a high quality finished product is achieved.



**Advantages of Gneuss Technologies for Repelletizing:**

- Decontamination of volatiles, oils and odors
- LNO for food contact use from the FDA for up to 100 % post-consumer recycled content
- Extraction of residual monomers
- Uniform, homogeneous pellets
- Amorphous, crystallized or highly viscous crystallized pellets
- High IV level
- Effective dispersion of fine particles
- High transparency, low yellowness



**LNO of FDA**

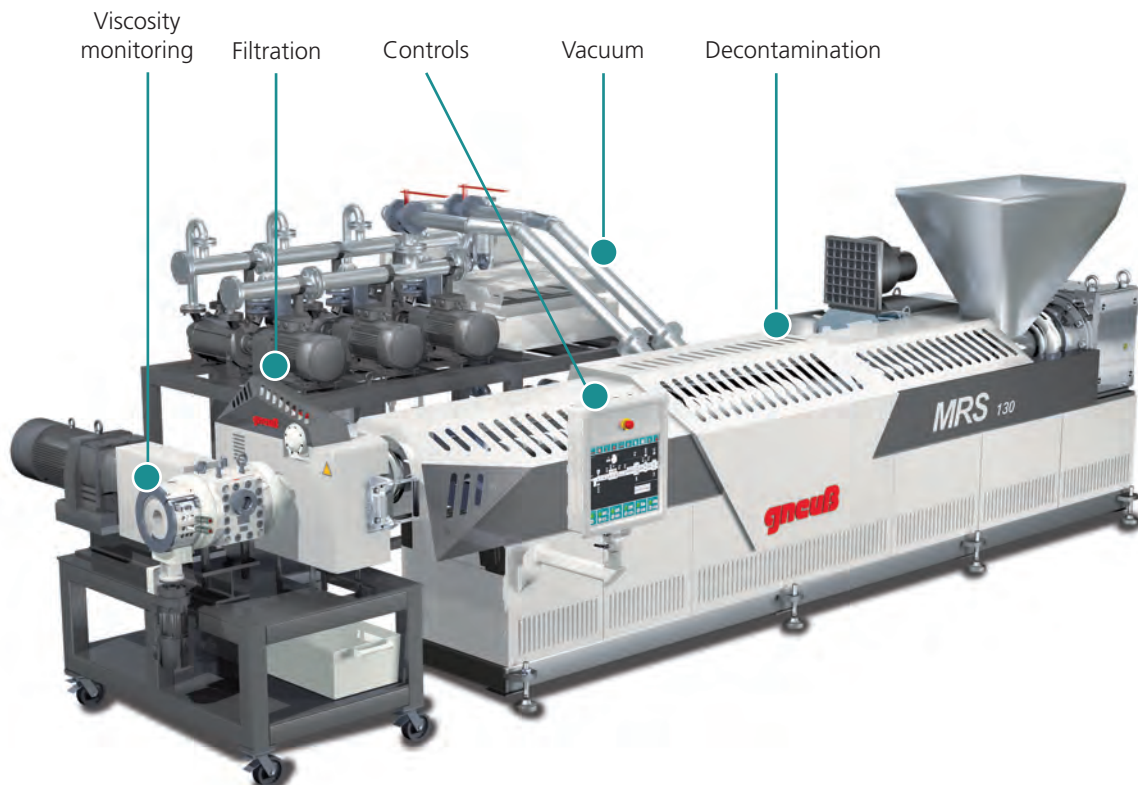
**Options:**

- Underwater pelletizing (amorphous, spherical shaped pellets)
- Underwater strand pelletizing (amorphous, cylindrical shaped pellets)
- Strand pelletizing (dry cut) with water bath (amorphous, cylindrical shaped pellets)
- Direct (residual heat) crystallization
- Continuous SSP for constant production of similar grades
- Discontinuous SSP for flexible production of different grades

# FIBER MANUFACTURE

Highest purity – best quality

The demand for environment-friendly and economically sound production lines for synthetic fibers is increasing worldwide. The Multi Rotation Extrusion System MRS fulfils both demands.



## Example of a Fiber Line

Multi Rotation Extruder MRS, Rotary Melt Filtration System RSF*genius*,  
Online Viscometer VIS, downstream for fiber spinning.

Gneuss extrusion lines are designed for manufacturing high quality fiber from PET post-consumer bottle flakes or from factory fiber waste with a wide range of different viscosities. Bicomponent (core / sheath etc.) staple fiber can for example be manufactured using the same input material and two different vacuum levels on two MRS extruders to deliver two melts with differing viscosities to the spinning beam.

Further applications for the MRS extruder include the processing of bottle flakes or production waste to carpet fiber (BCF) and nonwovens – also as bi-component fibers. By using PET bottle flakes, raw material cost savings can be achieved. MRS based extrusion systems can be combined with any kind of typical fiber downstream equipment.

### Advantages of Gneuss Technologies for Fiber Manufacture:

- Uniform polymer discharge:  
no fluctuations and variations
- High line availability
- Stable IV even when processing materials with varying residual moisture levels
- Different melt viscosities possible even when using the same input materials (viscosity can be set)
- Controlled, consistent viscosity
- Highest melt purity even when processing 100 % recycled material
- Fine filtration (12 to 40  $\mu\text{m}$ ).
- Major energy savings

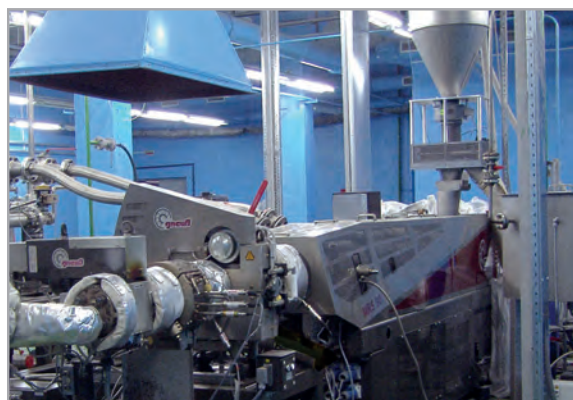


### Applications for Gneuss Technologies:

- Direct processing of PET bottle flakes or in-house waste to fiber products
- Processing of PET bottle flakes or in-house waste to pellets for subsequent extrusion to fiber products
- Processing of PET bottle flakes or in-house waste as melt stream directly into an existing polycondensation process

### Options:

- Integration into different extrusion spinning systems possible
- Retrofitting or conversion of existing spinning lines
- Tandem filtration

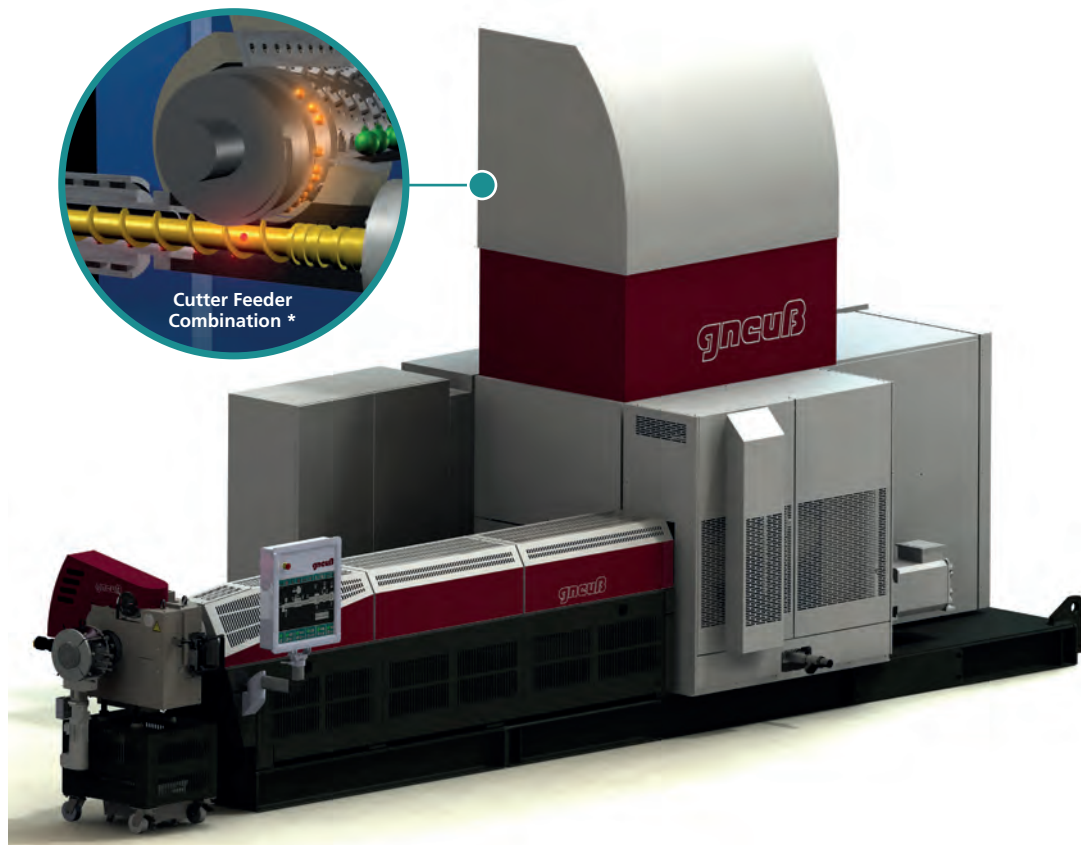


**MRS recycling system for reprocessing PET factory fiber waste (fibers coated with spin finish oils, start-up lumps etc.).**

# RECYCLING OF INDUSTRIAL WASTE

## Size Reduction and Agglomeration

In cooperation with worldwide specialists, Gneuss offers complete system solutions including size reduction (stand alone and integrated) and feeding.



\* © NGR - Next Generation Recyclingmaschinen GmbH

Several processing steps are reduced to one with the MRS direct recycling extruder with an integrated cutter / feeder system.

No preparation / size reduction of the material (fiber or thin film waste) is necessary. The slow moving cutter shreds the material and a screw feeder delivers the material into the screw.

Even fiber coated with spin finish oils and other contaminants and with a high residual moisture level can be fed directly into the extruder without any pre-treatment.

**Example of Direct Recycling Line**  
Cutter Feeder Combination,  
Multi Rotation Extruder MRS,  
Rotary Filtration System RSFgenius,  
Online Viscometer VIS

The material is plasticized, devolatilized and decontaminated in the extruder. Volatiles such as water or spin finish oils are extracted.

## Agglomeration:



Waste with a low bulk density (e.g. fiber waste, BOPET film waste) is cut and agglomerated (this step also includes some preliminary devolatilization). The agglomerated PET waste can then be fed directly to the extruder.



### Advantages:

- Continuous material feed
- Low thermal stress on the material
- Free flowing agglomerate with high bulk density
- Direct feeding to the extruder possible
- Efficient removal of larger contaminants possible (stones, metal pieces etc.)

### Advantages of Gneuss Technologies for Industrial Waste Recycling:

- Devolatilization of oils, odors and other volatiles
- Stable IV even when processing materials with varying residual moisture levels
- High transparency, low yellowness
- Controlled, consistent viscosity
- Highest melt purity
- LNO for food contact use from the FDA for 100 % post-consumer recycled content
- Major energy savings

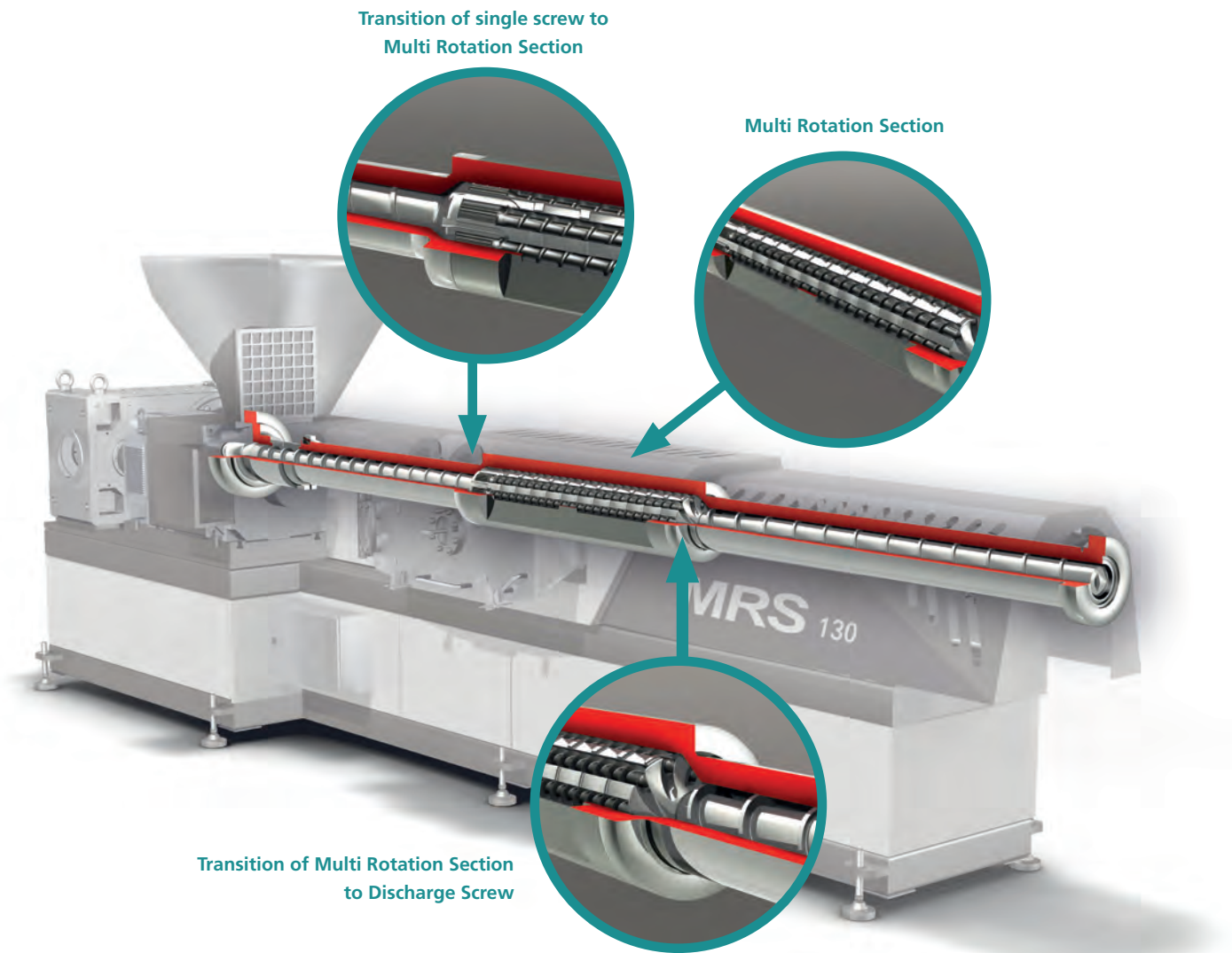


### Applications for Gneuss Technologies:

- Direct processing of inhouse-waste and/or edge trim to end products
- Processing of inhouse-waste and/or edge trim to pellets
- Processing of inhouse-waste and/or edge trim and as melt stream directly into an existing polycondensation process

# MRS EXTRUDER

## Design



The polymer melt is delivered into a large single screw drum. The drum contains 8 small extruder barrels, parallel to the main screw axis. Installed in these small extruder barrels are the „satellite“ screws, which are driven by a ring gear in the main barrel.

The satellite screws rotate in the opposite direction to the main screw while they rotate around the screw axis.

This disproportionately increases the surface area exchange of the polymer melt. The extruder barrels which are cut into the drum of the multi rotation system are approximately 30% open to ensure the optimum melt transfer into the barrels, so that the devolatilization can take place without restrictions.

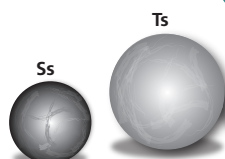
Further, precise control of the melt temperature is possible as the temperatures of all the surfaces in contact with the melt can be controlled accurately.

# MRS EXTRUDER

## High Performance Devolatilization

Thanks to its Multi Rotation Element, the surface area – and the surface area exchange rate – available for devolatilization are far greater than in other extrusion systems available on the market. The surface area of the steel parts in contact with the melt is exchanged at a rate of more than 25 times greater than with a co-rotating twin screw extruder. Due to the opposite rotation direction and high speed of the satellite screws, the polymer surface area is increased by a factor of 100 compared to a single screw extruder and a factor of 40 compared to a twin screw extruder. The devolatilizing performance of the MRS extruder can be summarized as follows:

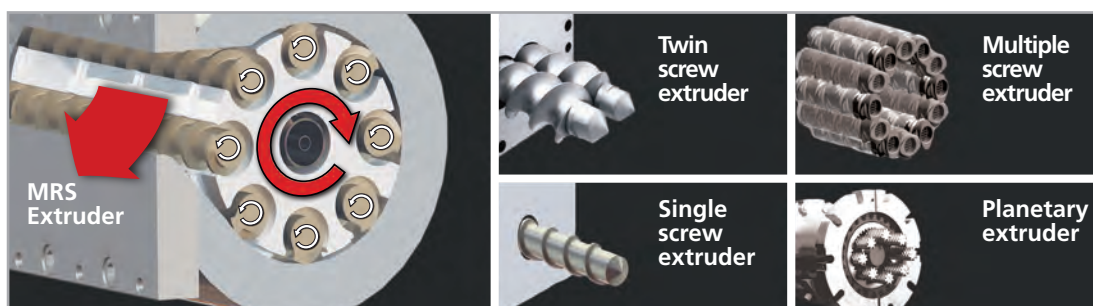
- MRS section = 800 m<sup>3</sup> / h\***
- Twin screw = 20 m<sup>3</sup> / h\***
- Single screw = 8 m<sup>3</sup> / h\***



**MRS Technology  
Devolatilization Performance**

\* These values were calculated on the following basis: **Throughput rate = 1000 kg / h**  
**Residual moisture level = 10 000 ppm**  
**Vacuum = 25 mbar**

### Important differences between the Gneuss MRS system and other screw concepts:



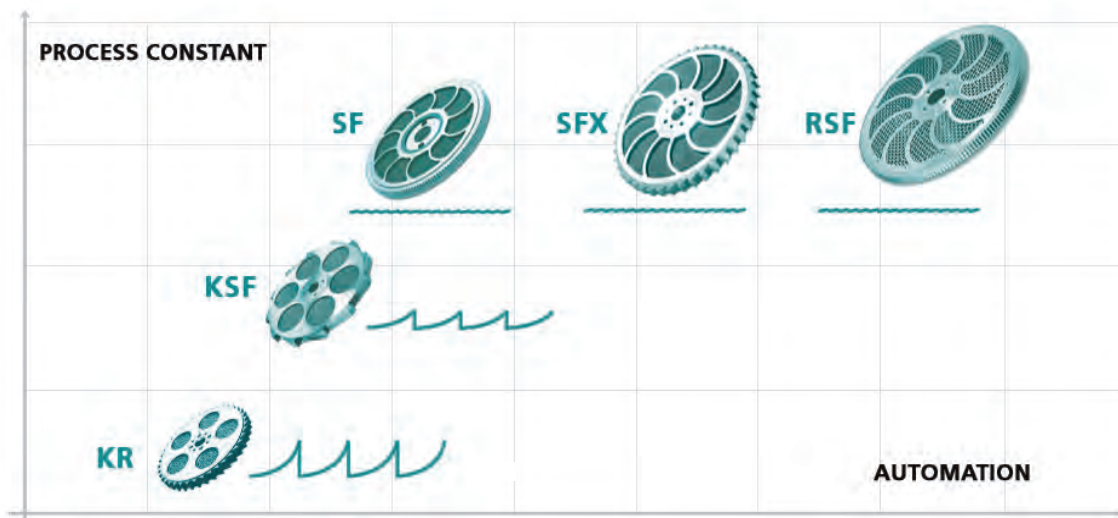
# ROTARY FILTRATION SYSTEMS

Constant. Guaranteed.

Filtration is the key to ensuring quality and cost efficiency not only in recycling applications. Rotary Filtration Systems from Gneuss represent the ideal solution, thanks to their continuous and pressure-constant operation.

## Overview of Gneuss Melt Filtration Systems

The lines below the Rotary Disks show the pressure curves in operation.



## The advantages of Rotary Filtration Systems

- Fully-automatic mode of operation (with integrated self-cleaning for RSF*genius*)
- Constant melt pressure, temperature, viscosity and throughput
- Guaranteed melt purity and quality, short dwell time of the melt
- Simple and safe screen changes, low filtration costs
- Compact size and minimal installation effort
- Rheologically optimized flow channel
- Minimal backflushing losses with self-cleaning RSF*genius* model





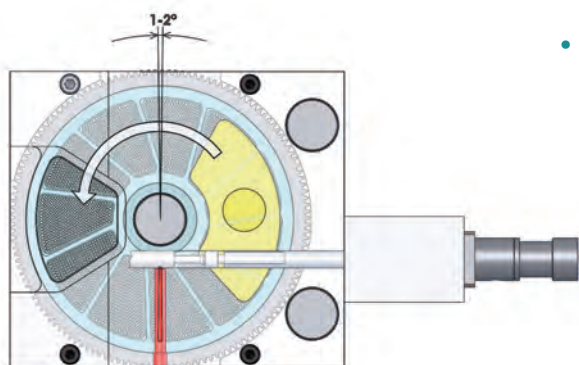
## The Rotary Filtration System explained Example: RSFgenius



Rotary Filtration Systems consist of three main parts – an inlet block, an outlet block and a filter disk rotating between them. The system is sealed by a metal to metal sealing with very narrow gaps as well as very hard and flat surfaces. It is guaranteed that all components in contact with melt are not in contact with the environment (e. g. oxygen). The screen elements are located in a ring pattern on the filter disk, moving through the melt channel. When melt flows through the screen, hard particles get caught and the differential pressure increases slightly.

The control system reacts to this pressure increase and makes the filter disk index by 1-2 angular degrees. Thus, contaminated screen area is continuously moved out of the melt channel and clean screen area is moved into the melt channel without changing the active filter area. Due to this mode of operation, the filtration system operates process- and pressure-constantly. The variation of the pressure differential across the filter ( $\Delta p$ ) amounts to max. 2 bar.

### The self-cleaning (backflushing) system

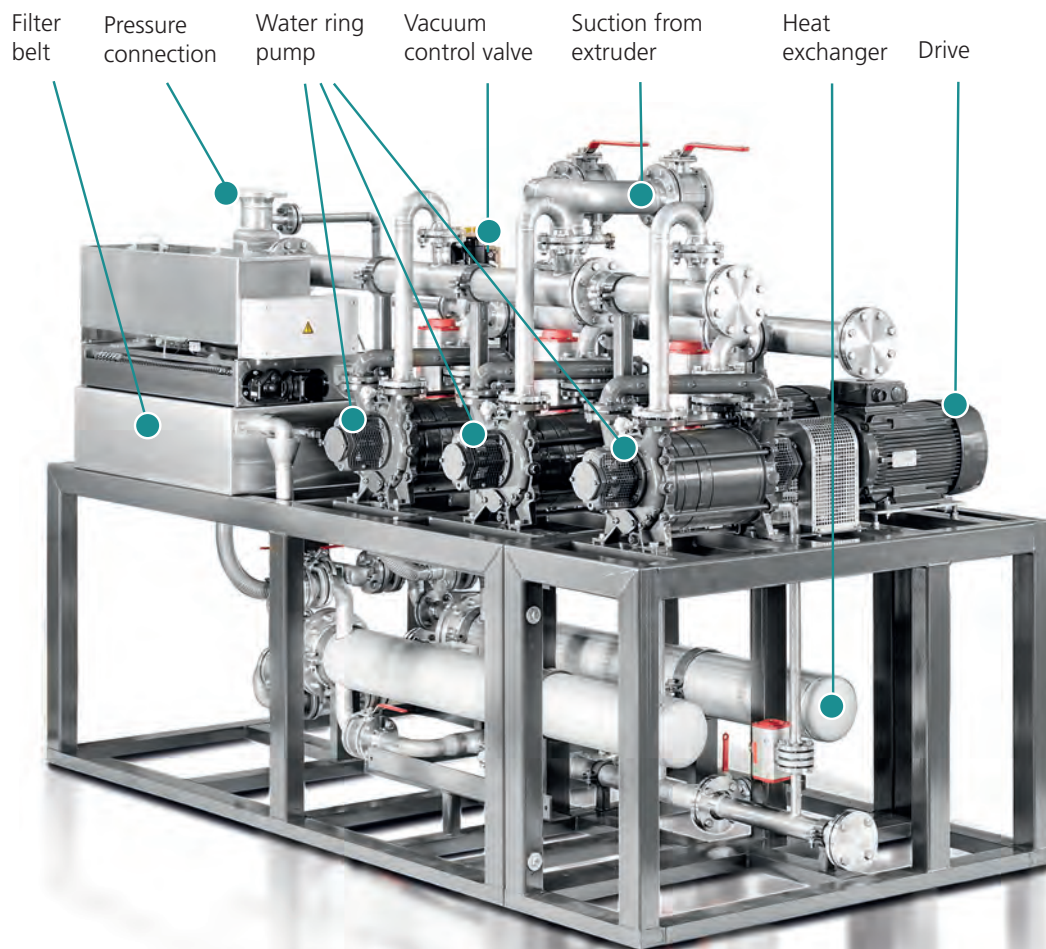


- A high pressure, sequential back flushing systems cleans the contaminated screen packs before they re-enter the melt channel.
- Polymer from the clean (filtered) side of the screen changer is siphoned into a hydraulically operated piston that shot with 30 to 80 bar across the filter element (in the reverse direction).
- Only one small segment (approx. 1 % of the filtration area) is cleaned at a time, with a defined, high pressure impulse.

# VACUUM TECHNOLOGY

## Highly efficient devolatilization

The vacuum system plays a key role in the devolatilization process. Not only is it important to create a vacuum – the separation of solid particles from the volatiles which are extracted from the melt presents a particular challenge.



### Advantages of the MRS Vacuum Technology:

- Handles liquids, vapor and solid particles
- Isothermal compression  
(no contamination during condensation)
- Oil free compression  
(no contamination during condensation)
- Simple design with water ring pump and belt filter
- Robust and not sensitive to blocking of suction and pressure pipes
- Standard vacuum level of 25 mbar

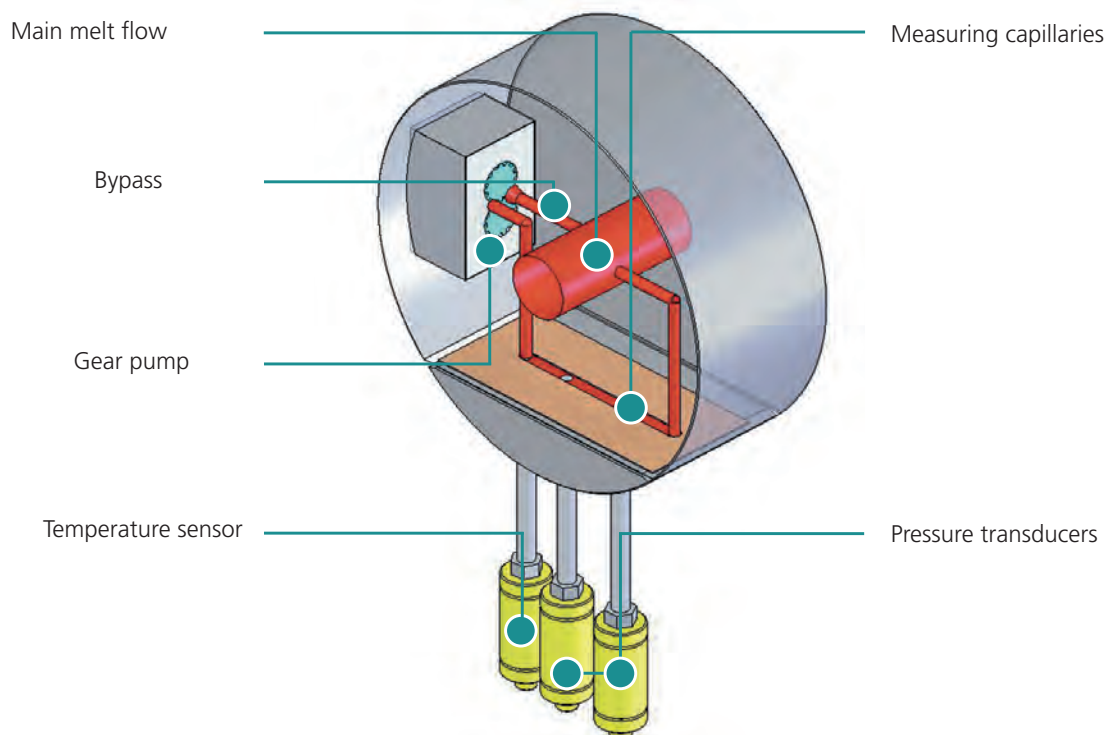
## ONLINE VISCOMETER VIS

Reliable and accurate viscosity measurement



The Gneuss Online Viscometer offers precise measurements of polymer properties which have a decisive influence on the product quality. The measured viscosity is in direct relationship to the physical properties of the material such as tensile strength and impact resistance. Quality assurance can be improved through the monitoring and recording of this data.

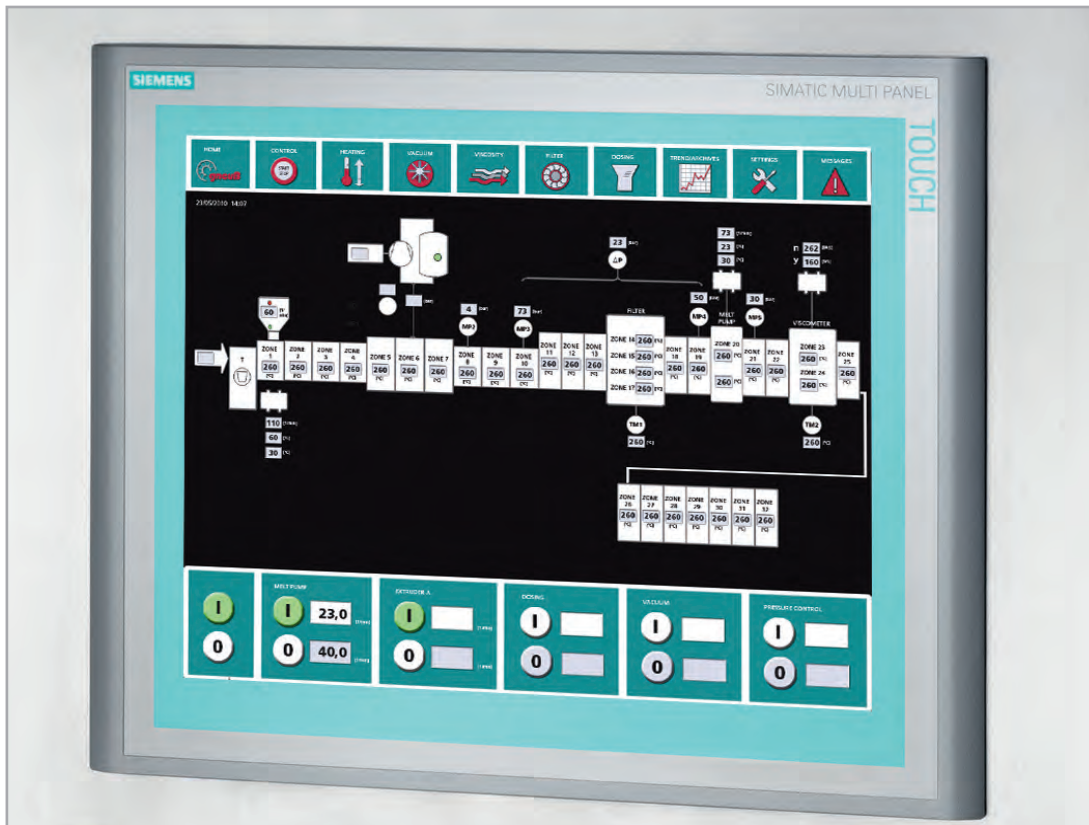
By means of a high precision metering gear pump, a small part of the polymer melt is separated from the main melt channel and pumped through a precisely manufactured slot capillary.



# CONTROL TECHNOLOGY

## The MRS control system

The control system is a key element in any extrusion line. Today, a control system is expected to link all the line components together in an efficient and operator friendly central system.



The standard control system hard- and software supports the following line components:

- Heater controls for the complete line
- Extruder drive
- Melt pump drive
- All melt pressure measurements
- Vacuum system
- Online Viscometer
- Rotary Melt Filtration System
- Dosing
- Pelletizer

The individual integration of interfaces and Bus systems permits the communication of control systems from various suppliers.

The MRS can be supplied with a telemaintenance facility via the internet. The telemaintenance client is integrated into the customer network and when required, connects with the Gneuss server. The security of the customer's network is protected.

## TRANSDUCERS FOR PRESSURE AND TEMPERATURE

### High quality and accurate Sensor Technology

The assurance of product quality and reliability is of great importance in the plastics extrusion industry. Superior performance is now defined by precise accuracy, extended life, and robust design for challenging environments.

#### Advantages of Gneuss Measurement Technology:

- Long life
- Non-mercury
- Excellent value for money
- Worldwide distribution
- Made in Germany
- Custom-built sensors
- Repair Program



## Protection against Over Pressure for Extrusion Lines

Throughout the world, the requirements on plastics processing and rubber machinery with regard to safety protection against over pressure are increasing.

With Gneuss' safety system EPM, the use of stretch bolts, fail safe components, rupture discs or movement sensors can be avoided.

Extruders, melt pumps or components which are under pressure can be protected against excess pressure by the EPM safety system, with a duplicated and monitored pressure measurement. The safety-relevant components of the monitoring system conform to EN ISO 13849-1, with a performance level of "c".

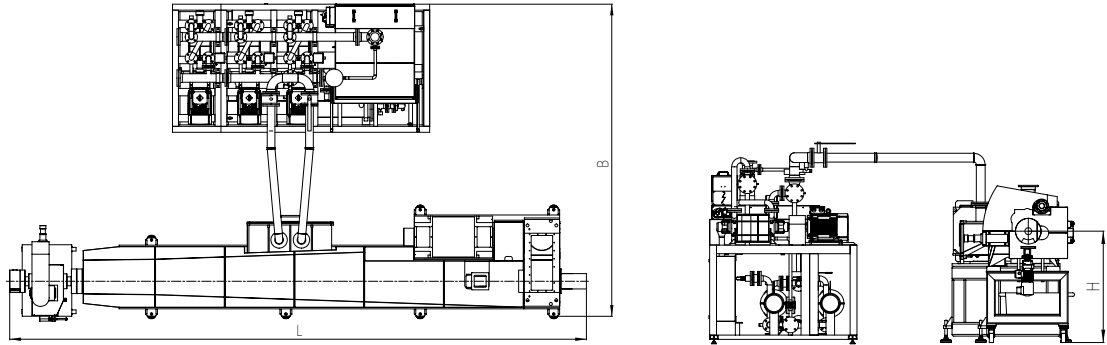


#### Gneuss Solution: Safety System EPM

- Designed according to EN1114-1
- Two redundant sensors 4...20 mA, to which the same pressure is applied
- Two safety-related analogue inputs
- Self-monitoring
- Two safety-related relay outputs, the emergency stop of the unit
- 4...20 mA signal for pressure evaluation
- Optional Bus interface

# POLYESTER RECYCLING LINE

## Polyester Recycling System: Overview of Complete System Solutions



Subject to modifications.

Technical Data Gneuss Recycling Line*								
<b>Throughput rate in kg/h</b>								
<b>PET</b>	...	80	180	400	500	950	1400	2000
<b>PP + PE</b>	25	60	130	300	450	750	1000	1600
<b>PA</b>	28	70	160	360	560	880	1200	1900
<b>Drive rating kW</b>								
	18	41	105	165	235	335	520	860
<b>MRS Extruder</b>								
	MRS 35	MRS 50	MRS 70	MRS 90	MRS 110	MRS 130	MRS 160	MRS 200
<b>RSFgenius Filter 75-160 µm</b>								
	RSF 45	RSF 60	RSF 60	RSF 75	RSF 90	RSF 150	RSF 175	RSF 200
<b>SFXmagnus Filter 75-160 µm</b>								
	SFX 45	SFX 45	SFX 60	SFX 75	SFX 90	SFX 130	SFX 150	SFX 175
<b>Online Viscometer</b>								
	VIS	VIS	VIS	VIS	VIS	VIS	VIS	VIS
<b>Vacuum</b>								
	VAC 143	VAC 183	VAC 303	VAC 403x1	VAC 403x2	VAC 403x3	VAC 403x4	VAC 403x5
<b>Overall dimensions</b>								
<b>Extrusion height H mm</b>	1000	1000	1150	1150	1300	1300	1450	1450
<b>Length L mm</b>	3375	3425	4475	5575	6575	7625	11050	13350
<b>Width B mm</b>	2282	2382	2080	4120	4195	4320	4470	5050
<b>Weight approx. kg</b>	2350	3850	5050	7450	8300	11100	16650	21100

\* Standard values. Specific variations and individual configurations of the components are possible.

# ALWAYS SOMEWHERE NEAR YOU

## Our Locations

Based in Bad Oeynhausen, Germany, Gneuss is committed to the expectations of products "made in Germany" while serving customers world-wide. A technology center for processing technical trials and development work is available at

Gneuss' headquarters in Bad Oeynhausen. Pilot lines are also available for trials at our subsidiary, Gneuss Inc. in the USA and at our cooperation partner, SysTech in Japan.



### Subsidiary

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